I-75 Modernization Traffic Noise Analysis Segment 12b

Oakland County, Michigan

Project Description

The I-75 roadway improvement project is located in Oakland County, Michigan. The February 2015 Noise Report represents an update to the Final Environmental Impact Statement (FEIS) that was completed in May 2005. The present analysis addresses updates to the Michigan Department of Transportation (MDOT) traffic noise policy guidelines and impact criteria that became effective in 2011. The July 2011 *MDOT Highway Noise Analysis and Abatement Handbook* outlines these policy changes. In addition to the policy updates, future predicted noise levels were determined using Federal Highway Administration (FHWA) TNM 2.5 model rather than the TNM version 2.1 used during the FEIS phase. Figure 1 illustrates the overall project study area with Segment 12b shown in the upper left hand corner. Figure 2 depicts general the Fox Hills community and the receptor locations where noise modeling was completed. The Fox Hills community is bounded by South Boulevard to the north, Square Lake Road Business Loop off-ramp from I-75 southbound to the east, Opdyke Road off-ramp from the Square Lake Road Business Loop to the south, and Opdyke Road to the west. This area was not included in the original noise study since at that time no design changes were proposed in this area. In addition, the portion of this community located south of the construction paving limits was excluded from this evaluation.

Fundamental Concepts of Roadway Noise

Sounds occur in the human and natural environment at all times. Some sounds are necessary or desirable for communication or pleasure, some are unnoticed, and other sounds are unwanted, causing annoyance and disturbance to the people living or working in the area. Therefore, by definition, unwanted sound is referred to as noise. The following sections provide a background for some of the physical properties and terminology of sound and noise.

A-WEIGHTED SOUND LEVEL

From many experiments with human listeners, scientists have found that—unlike animals—the human ear is more sensitive to midrange frequencies than to either low or very high frequencies. Therefore, at the same sound level, the human ear hears midrange frequencies as perceived louder than low or very high frequencies. This characteristic of the human ear, is taken into account by adjusting or weighting the spectrum of the measured sound level for the sensitivity of human hearing range. The weighting scale that best accounts for the sensitivity of the human hearing range is referred to as the A-weighted scale and is denoted by “dBA” notation. The A-weighted sound level is a measure of sound intensity with one-third octave frequency characteristics that correspond to human subjective response noise.

Figure 1 – TNM Modeling Segments

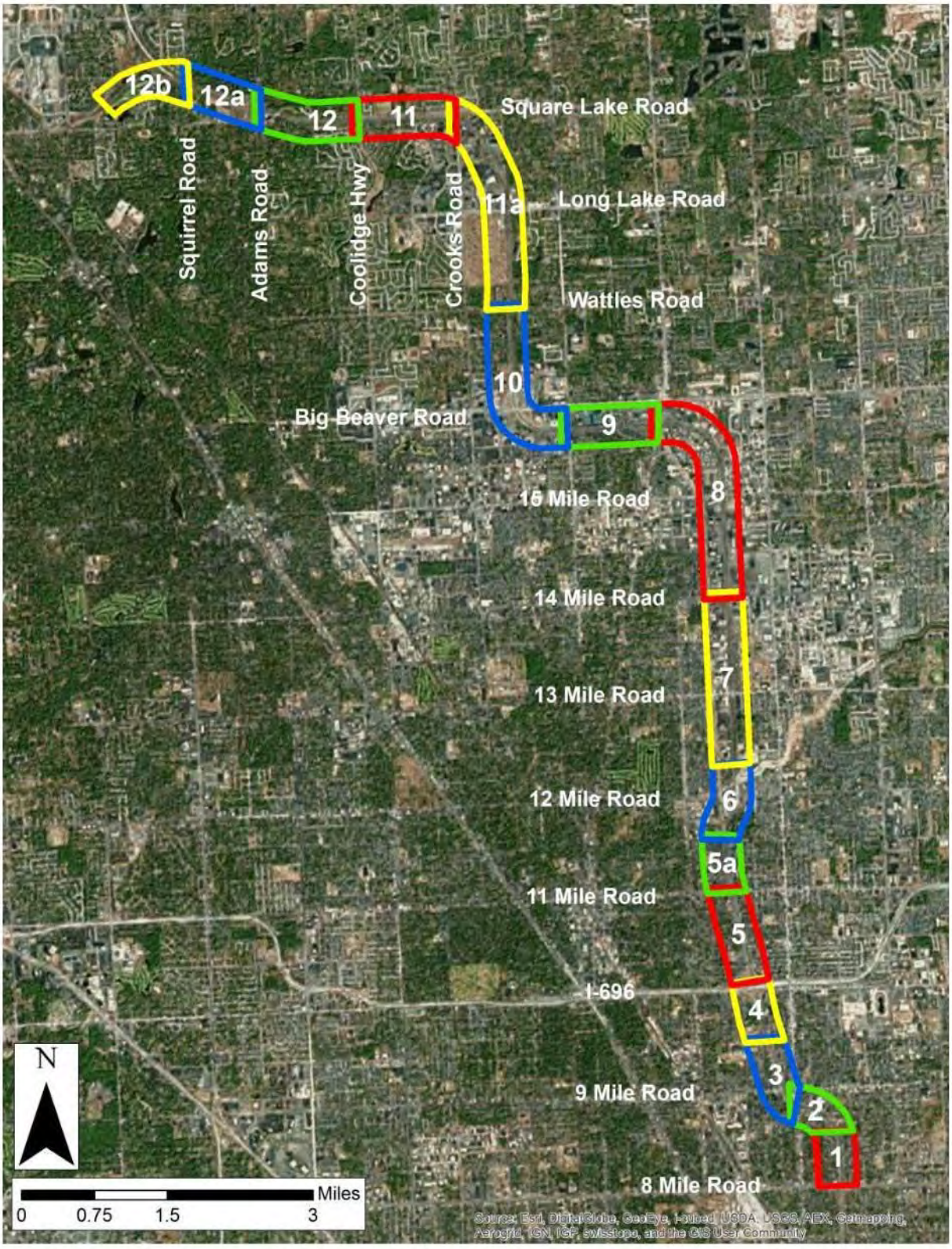

Figure 2 – Fox Hills Study Area

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Acousticians accept the A-weighted sound level as a good descriptor for assessing human exposure and annoyance from environmental noise. Figure 3 illustrates some common noise levels.

An understanding of the following relationships is helpful in providing a subjective impression of changes in the A-weighted sound level:

- An increase of only 1 dB in A-weighted level cannot be perceived, except in carefully controlled laboratory experiments.
- A 3 dB increase in A-weighted level is considered a just-noticeable difference outside of the laboratory.
- A change in A-weighted level of at least 5 dB is required before any significant change in the noise level in a community is perceived.
- A 10 dB increase in A-weighted level is subjectively heard as approximately a doubling in loudness, independent of the existing noise level.

Noise Level Descriptors

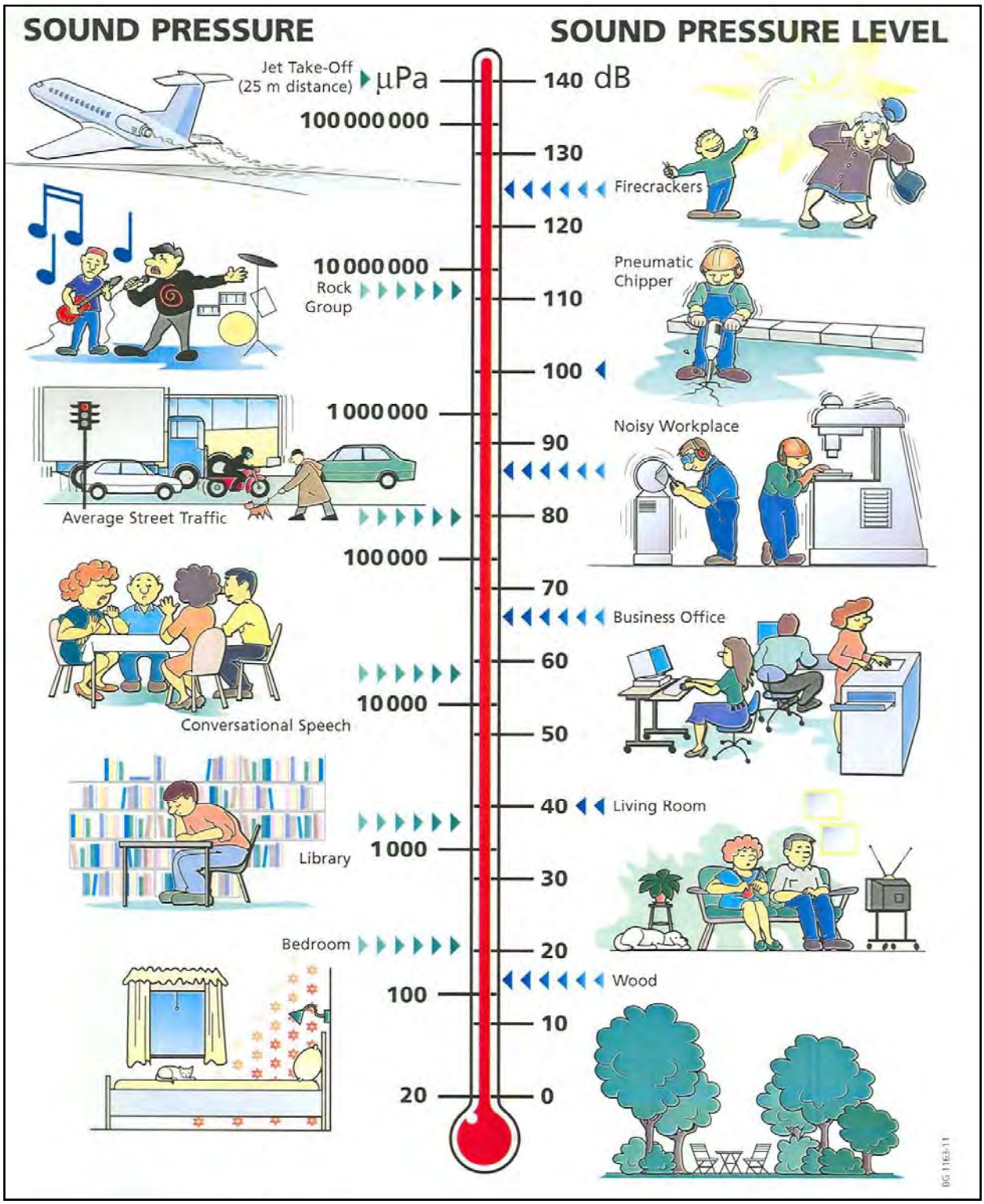
A basic characteristic parameter of environmental noise near, particularly near roadways, is its time-varying nature that fluctuates from moment to moment. These fluctuations constitute the time-varying property of roadway noise. Because traffic noise fluctuations vary from moment to moment, it is common practice to condense all of the information into a single number, called the "equivalent" sound level (L_{eq}). The L_{eq} is a measure of the average sound energy during a specified period of time (typically 1-hour duration). The L_{eq} is defined as the constant level that, over a given period of time, transmits the same amount of acoustical energy to the receiver as the actual time-varying sound. Studies have shown that the A-weighted L_{eq} noise descriptor is well correlated with human annoyance to sound; therefore, this descriptor is widely used by government agencies for environmental noise impact assessment. The L_{eq} measured over a 1-hour period is referred to as the hourly L_{eq} or L_{eq} (1-hour) and has been established by Federal Highway Administration as the preferred noise descriptor to evaluate to analyze and assess highway traffic noise exposure.

Noise Impact Criteria

The I-75 Modernization Project, in Oakland County, Michigan is categorized as Type I roadway improvement. This classification refers to projects that include federal funding for construction of highways on a new location or the alteration of an existing highway resulting in substantial change in either alignment or the number of through-traffic lanes. The noise analysis for this project was conducted in general compliance with Code of Federal Regulations (CFR), Title 23, Part 772, the United States Department of Transportation, Federal Highway Administration (FHWA), *Highway Traffic Noise Analysis and Abatement - Policy and Guidance* (FHWA, 1995). The basic goals of noise criteria, as they apply to highway projects, are to minimize potential adverse noise impacts on the community and, where necessary and appropriate, to provide feasible and reasonable measures to abate noise impacts.

To determine if highway noise levels are compatible with various land uses, the FHWA has developed noise abatement criteria and procedures to be used in the planning and design of highways. A summary of the FHWA Noise Abatement Criteria (NAC) for various land uses is presented in Table 1. These NAC levels represent the upper limit of highway traffic L_{eq} (1-hr) noise levels for exterior land uses and activities, and also for certain indoor activities. Impact occurs when the predicted noise level at a receptor approaches or exceeds the FHWA NAC, or when the difference between existing and future noise levels is considered a substantial increase.

Figure 3 – Typical Noise Levels



Source: Bruel and Kjaer: Environmental Noise, Sound and Vibration Measurements, 2000.

The Michigan Department of Transportation (MDOT) have their specific interpretation of the federal requirement and policy procedures governing traffic noise outlined in their *MDOT Highway Noise Analysis and Abatement Handbook,* July 2011. MDOT defines "approach" as being within one decibel (dBA) of the NAC. Therefore, all properties covered by NAC B (generally residential) that have a calculated L_{eq} levels of 66 dBA or higher would "approach or exceed" NAC B criterion. Similarly, all properties covered by NAC C (commercial, industrial, and manufacturing) with L_{eq} values of 71 dBA or higher would "approach or exceed" NAC C criteria. Therefore, L_{eq} levels of 66 dBA or greater for NAC B, and 71 dBA or greater for NAC C were used as threshold impact values. In addition to the approach impact threshold MDOT consider an impact to occur if there is "substantial" noise level increase is projected to occur. A substantial noise level increase is defined as when predicted build traffic noise levels increase by 10 dBA or more above the corresponding existing noise level. Therefore, a noise impact can occur two separate ways: either when build noise levels approach or exceed the NAC or when substantial increase from existing to project build conditions is predicted to occur.

When a traffic noise impact are identified to occur, noise mitigation must be considered. A noise abatement measure is any positive action taken to reduce the impact of traffic noise on an activity area. Consideration for noise abatement in communities where impacts are projected to occur does not in itself guarantee the abatement is warranted. For the areas where impacts are identified, methods of noise abatement are evaluated to determine the feasibility and reasonableness of their implementation. The evaluation is based on many factors, some of which include engineering constructability, restriction to traffic flow or property accessibility, cost effectiveness, required height of wall, acoustic effectiveness of the barrier to reduce traffic noise and whether changes to the existing land use are expected. The specific requirements for feasibility and reasonableness are described in the next section.

Feasibility and Reasonableness

In the communities where impact is projected to occur, MDOT has defined specific two-step process requirements to determine if abatement is can is possible. The following two steps (in the order shown) are considered:

(1) Is it **feasible** to provide highway traffic noise abatement from engineering, safety and the acoustic effectiveness standpoint?
(2) Is it **reasonable** to provide highway traffic noise abatement based on the consideration of the cost/benefit analysis, view point of a majority of the benefiting residences and property owners, and in providing sufficient noise attenuation?

A. **Step 1 Feasibility Consideration:** Once the impact determination process is completed the noise abatement design is driven into the feasibility phase. If a proposed sound barrier does not pass the feasibility phase it does not go into the reasonableness phase. The following factors are considered in the feasibility phase:

(1) Can a noise reduction of at least 5 dB(A) be achieved by 75% of impacted receptors?
(2) Can the noise barrier be designed and physically constructed at the proposed location?
(3) Will placement of the barrier cause a visual safety problem?
(4) Will placement of the noise barrier restrict access to vehicular or pedestrian travel?
(5) Will the noise barrier impact utilities or will the utilities impact the noise barriers?
(6) Will the noise barrier impact drainage or will the drainage impact the noise barrier?

Table 1

FHWA Noise Abatement Criteria (NAC)[1]
Hourly A-Weighted Sound Level in Decibels (dB(A))

ACTIVITY CATEGORY	ACTIVITY CRITERIA[2]		EVALUATION LOCATION	ACTIVITY DESCRIPTION
	$L_{eq}(h)$[3]	L10(h)[4]		
A	57	60	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[5]	67	70	Exterior	Residential.
C[5]	67	70	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools , television studios, trails, and trail crossings.
D	52	55	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[5]	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	--	--		Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--		Undeveloped lands that are not permitted.

[1] MDOT defines a noise impact as a 10 dB(A) increase between the existing noise level to the design year predicted noise level OR a predicted design year noise level that is 1 dB(A) less than the levels shown in Table 1.
[2] Either $L_{eq}(h)$ or L10(h) (but not both) may be used on a project. MDOT uses $L_{eq}(h)$. The $L_{eq}(h)$ and L10(h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
[3] L_{eq} is the equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period, with $L_{eq}(h)$ being the hourly value of L_{eq}.
[4] L10 is the sound level that is exceeded ten percent of the time (90th percentile) for the period under consideration, with L10 being the hourly value of L10.
[5] Includes undeveloped lands permitted for this activity category.

B. **Step 2 Reasonableness Consideration:** Once the feasibility phase has been evaluated and satisfied a proposed noise barrier is evaluated for reasonableness. If a proposed sound barrier does not pass the feasibility phase it is no longer considered viable. The following elements are considered in the reasonableness phase:

(1) Assuming a $45 per square foot unit cost, can a proposed noise barrier, considering its total square-footage (length multiplied by height) be constructed such that the cost per benefiting unit (CPBU) remain below $44,187 (in 2014) allowable limit. Moreover, the proposed noise barrier design should be optimized as much as possible to reduce the cost per benefiting receptor to much less than the $44,187 maximum limit.

(2) A benefited receptor is an impacted receptor that receives a noise reduction of 5 dB(A) or greater noise reduction as a result of the noise barrier. On the other hand, benefits to non-impacted receptors regardless of the resulting insertion loss are not to be counted as benefited.
(3) In addition to the 5 dB(A) reduction at 75% of the impacted receptors established during the reasonableness phase. The reasonableness phase requires the proposed sound barrier to achieve a noise reduction of 10 dB(A) or more at one benefiting receptor and provide at least a 7 dB(A) reduction for 50% or more of the benefiting receptor sites.

Existing Ambient Noise Levels

Existing ambient noise levels along the first row of properties within the Fox Hills community are in the 63-70 dBA range. Table 2 provides the existing peak hour noise levels.

Table 2 – Summary of Existing Peak Hour Leq (1hr) dBA Noise Levels

Time Period	Receptor R4a	Receptor R11	Receptor R69
Peak AM	65 dBA	70 dBA	69 dBA
Peak PM	63 dBA	68 dBA	67 dBA

Future 2035 Build Conditions Noise Level Estimates

The Fox Hills community was not included in the original noise study since at that time no design changes were proposed in this area. However, since then there have been some proposed minor highway design improvements. In addition, the area south of the construction limits was not included in this noise impact assessment and abatement analysis.

Table 3 provides a summary of the predicted future 2035 Build noise levels within the Fox Hills community. In addition these receptor sites are illustrated on Figure 4. Receptor sites with a green dot indicate locations where no impact is projected to occur and those with a red dot indicate a noise level above 66 dBA. In general, predicted unabated noise levels above the 66 dBA impact threshold would occur at first-row properties closest to I-75 that have a direct-line-of-site to the highway. Second and third-row properties would experience noise levels well below the 66 dBA impact threshold Furthermore, the vast majority of properties within the Fox Hills community, as indicated by the green dots on Figure 4, are projected to experience noise levels well below the 66 dBA impact threshold.

Noise level estimates within the northern most residential area closest to South Blvd were found to be below the 66 dBA impact threshold with the exception of receptor R4a. This residential area is shielded from I-75 traffic noise by a community built noise wall, as illustrated in Figure 4 by the solid green line. Noise levels at receptor Site R4a are projected to reach 66.4 dBA under future build conditions.

Table 3 – Summary of Fox Hills Community Predicted Future Build Unabated Noise Levels & Noise Reduction Achieved with Abatement

RECEPTOR ID	PREDICTED 2035 UNABATED BUILD NOISE LEVEL LEQ (1 HR) DBA	MDOT/FHWA IMPACT (YES/NO)	NOISE REDUCTION ACHIEVED WITH ABATEMENT (NUMBER OF BENEFITS)
R1	63.1	No	0.0
R2	61.0	No	0.0
R3	64.6	No	0.3
R4	60.0	No	0.0
R4a	**66.4**	**Yes**	0.4
R4b	60.8	No	0.0
R5	65.8	No	3.4
R5a	64.7	No	3.7
R5b	62.9	No	3.7
R5c	62.3	No	3.0
R5d	60.6	No	3.6
R6	60.6	No	3.3
R7	61.4	No	4.4
R8	**68.0**	**Yes**	**5.1 (1)**
R9	62.7	No	4.9
R10	59.8	No	5.0
R11	**71.8**	**Yes**	**7.0 (10)**
R12	57.3	No	3.5
R13	54.9	No	0.3
R14	64.7	No	3.6
R15	65.0	No	2.9
R15a	64.1	No	1.3
R16	61.8	No	2.5
R17	61.7	No	2.1
R18	57.2	No	1.3
R19	56.9	No	1.6
R20	56.7	No	2.2
R21	57.0	No	2.5
R22	57.6	No	2.9
R23	56.2	No	1.5
R24	53.4	No	1.2
R25	55.7	No	0.8
R26	54.3	No	0.4
R27	56.3	No	0.7
R28	56.4	No	0.8
R29	53.6	No	1.0
R30	53.9	No	0.0

Table 3 – Summary of Fox Hills Community Predicted Future Build Unabated Noise Levels & Noise Reduction Achieved with Abatement (continued)

RECEPTOR ID	PREDICTED 2035 BUILD UNABATED NOISE LEVEL LEQ (1 HR) DBA	MDOT/FHWA IMPACT (YES/NO)	NOISE REDUCTION ACHIEVED WITH ABATEMENT (NUMBER OF BENEFITS)
R31	49.3	No	0.9
R32	57.4	No	0.9
R33	57.1	No	0.9
R34	55.0	No	0.6
R35	55.6	No	0.7
R36	54.2	No	1.0
R37	52.2	No	1.5
R38	49.8	No	1.6
R39	57.0	No	0.9
R40	57.5	No	0.9
R41	58.3	No	1.1
R42	59.0	No	1.4
R43	59.9	No	1.7
R44	61.2	No	2.3
R45	62.8	No	3.3
R46	65.0	No	5.0
R47	**67.7**	**Yes**	**7.4 (1)**
R48	**71.8**	**Yes**	**9.4 (1)**
R49	**70.8**	**Yes**	**10.0 (1)**
R50	49.4	No	0.4
R51	51.1	No	0.8
R52	50.5	No	1.5
R53	49.2	No	0.2
R54	52.2	No	2.0
R55	53.7	No	1.8
R56	52.5	No	2.4
R57	58.0	No	3.8
R57a	54.6	No	2.5
R58	62.3	No	5.1
R59	59.5	No	4.1
R60	54.6	No	3.0
R61	**74.0**	**Yes**	**9.7 (1)**
R62	**68.9**	**Yes**	**6.0 (1)**
R63	**67.0**	**Yes**	4.2
R64	63.2	No	2.9
R65	60.4	No	2.0

Table 3 – Summary of Fox Hills Community Predicted Future Build Unabated Noise Levels & Noise Reduction Achieved with Abatement (Continued)

RECEPTOR ID	PREDICTED 2035 BUILD NOISE LEVEL LEQ (1 HR) DBA	MDOT/FHWA IMPACT (YES/NO)	NOISE REDUCTION ACHIEVED WITH ABATEMENT (NUMBER OF BENEFITS)
R66	58.5	No	2.3
R67	54.8	No	3.1
R68	44.5	No	0.3
R69	**71.2**	**Yes**	**5.7 (1)**
R70	63.4	No	3.7

In communities that do not benefit from the existing wall, future TNM predicted Build noise levels at or above the MDOT 66 dBA impact criteria, are projected to occur at nine receptor sites identified as R8, R11, R47, R48, R49, R61, R62, R63, and R69. Receptor sites R8 and R11 are outdoor exterior areas associated with the preschool and the remaining noise impacts occur at residential properties. Receptor site R11, the preschool, represents ten equivalent dwellings and all the other impacted sites represent one equivalent dwelling. Therefore the nine impacted sites represent 18 impacted receivers (equivalent dwellings). Predicted noise levels ranged from minimum impact level of 67.7 dBA at R47 to a maximum noise level of 74 dBA at R61 both residential properties located on at the southernmost extent of the study area.

Future 2035 Build Conditions with Abatement

Figure 5 depicts the two proposed sound barriers within the project construction limits. The area between the two evaluated walls would not be impacted therefore a sound barrier is not proposed. Table 3 provides a summary of the achieved noise reduction levels, and total number of benefitted receivers is shown in parenthesis. Table 4 provides a summary of the feasibility and the reasonableness analysis. As indicated in Table 4, the two combined sound barriers would achieve adequate noise reduction. The proposed sound barriers would satisfy MDOT feasibility requirements for acoustic effectiveness by achieving a noise reduction of 5 dBA at 94-percent of the impacted receivers and 7 dBA at 78 % of the impacted receivers. However, the unit cost per benefitted dwelling was estimated to be approximately $85,230; which is nearly two times above MDOT's $44,187 dollar maximum allowable limit. Therefore, based on the high cost per benefitted receiver, the evaluated sound barriers are not recommended.

Table 4 – Feasibility and Reasonableness Assessment

Impacted Receivers behind Proposed Sound Barrier(s)	18
Benefitting Receivers	17
# of Impacted with 5dB(A) Reduction	17
% of Impacted with 5dB(A) Reduction	94%
# of Impacted with 7dB(A) Reduction	14
% of Impacted with 7dB(A) Reduction	78%
# of Impacted with 10dB(A) Reduction	1
Total Cost (dollars)	$1,363,685
Cost Per Benefitting Receiver (dollars)	**$85,230**
Total Length (feet	1,980
Average Height (feet)	16.1

Conclusion

The study findings indicate that generally first-row residential properties facing I-75 within the Fox Hills community would experience design-hour 2035 peak-noise levels above the 66 dBA impact criteria. Proposed sound barriers to mitigate these impacts would be acoustically effective; however, the cost per benefitting dwelling would be well above MDOT's $44,187 maximum allowable reasonable limit. Therefore, abatement is not recommended for this area.

Figure 4 – Summary of Impacted Receivers

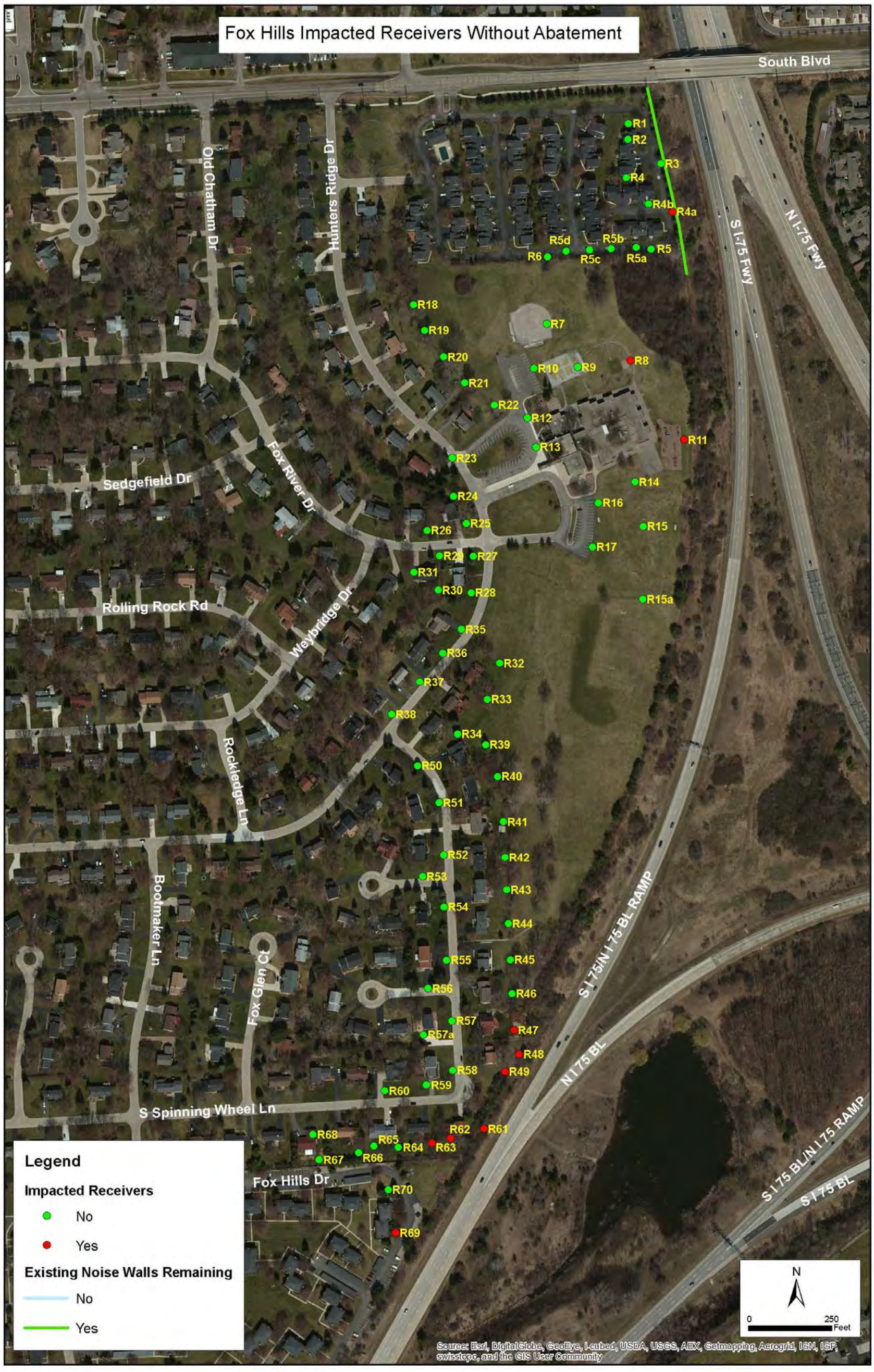


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Figure 5 – Summary of Tested Noise Barriers & Benefitting Receivers

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